PATENT SPECIFICATION (11) 1 431 243

(21) Application No. 10237/74 (22) Filed 7 March 1974 (19)

(44) Complete Specification published 7 April 1976

(51) INT. CL.[2] H01Q 13/20 H04B 7/00

(52) Index at acceptance
H4A 6G 6TX 8
H4L 11E

1 431 243

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(54) RADIATING CABLE ARRANGEMENT

(71) We, STANDARD TELEPHONES AND CABLES LIMITED, a British Company, of 190 Strand, London, W.C.2, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a radiating cable arrangement, such as is used for communicating with moving vehicles on road or rail systems. In such systems signals are transmitted from a base station along a length of radiating cable running beside a road or railway track. Suitable equipped vehicles travelling along the road or track can receive the signals when the vehicle is within the effective field surrounding the cable.

The total path loss between the base station and the mobile vehicle radios is made up of three components:—

(a) the basic coupling, this is the mean path loss between the feed point of the radiating cable and a mobile antenna located at the desired position outside the cable near the feed end

(b) the insertion loss of the cable for the length required, this is the difference in power level (in dB) between the power at the energised end of the cable and the power level (in dB) at the termination end of the cable.

(c) standing wave variations. These are rapid variations superimposed on the other two such that the total loss varies between more or less than (a)+(b) when the distance along the cable is varied by about 2 metres (at 100 MHz).

In a communication system between cars moving on motorways and fixed stations, one might typically use cable lengths of one kilo metre having an insertion loss of 30 dB and a coupling of about 80 to 100 dB for vehicles some 15 metres from the cable. The magnitude of the standing waves may be up to 30 dB deeper than the mean, such that the maximum path loss may be up to (100+30+30) dB. If communication is to be achieved along the whole length of the cable then transmitter power and receiver sensitivity must be designed to fit with this maximum path loss.

According to this invention there is provided a radiating cable arrangement comprising a length of coaxial cable provided with longitudinally extending radiating means, means for feeding the cable at one end with modulated radio frequency signal, means for applying to the same end of the cable an audio frequency modulated bias signal, and at the other end of the cable means for terminating the cable and means responsive to the bias signal for modulating the standing wave pattern of the radiated signal at the frequency of the bias modulation.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:—

Fig. 1 illustrates a radiating cable arrangement,

Fig. 2 illustrates part of the arrangement of Fig. 1 in more detail,

Fig. 3 illustrates an alternative arrangement to that of Fig. 2, and

Fig. 4 illustrates a modification of the arrangement shown in Fig. 1.

Fig. 1 illustrates a radiating cable arrangement for a length of dual carriageway road. Carriageway 1 carries road traffic from West to East and carriageway 2 carries traffic in the opposite direction. In the central reservation 3 there is located a transmitter 4 feeding two lengths of radiating coaxial cable 5, 6. Each length of cable is terminated by a suitable impedance 7, 8 respectively. The transmitter 4 is used to transmit radio frequency signals containing messages.

The signal field surrounding the cables 5, 6 is made large enough so that a vehicle travelling along either carriageway and equipped with a radio receiver can receive the transmitted signals. By this means the vehicle driver can receive messages, for example, containing weather information for the road or warnings of hazards ahead such as accidents.

In any given short length of carriageway, such as that indicated QR, measurements of the field strength will indicate that significant variations occur corresponding to a standing wave pattern. If now the cable terminating impedance is altered, for example short-circuited, the standing wave pattern will change, although a pattern will still be present. The important point to note is that generally speaking the nodes of the two standing wave patterns will not coincide. If the standing wave pattern can be made to alter at a given frequency, say 6KHz, the total path loss between the transmitter and a vehicle receiver will vary in synchronism with the change in the standing wave pattern.

Fig. 2 illustrates the details of a suitable arrangement. The radiating cable 5 is terminated in a load 11 whose amplitude equals the characteristic impedance of the cable. In parallel with this load there is a pin diode 12. This diode has a reactance controlled by the applied bias. At the transmitter end in addition to the transmitter 4 there is an audio frequency bias oscillator 13 coupled to the cable via inductance 14. An isolating capacitance 15 is inserted in the transmitter coupling to stop the bias output of oscillator 13 from getting into the transmitter. A further capacitance 16 is inserted in the terminating network to stop the bias being dissipated in the load 11. The inductance 14 prevents the r.f. output of the transmitter from entering the oscillator 13. The bias output of the oscillator is modulated at a frequency outside the pass band of the vehicle receiver. The parameters of the arrangement are chosen so that the pin diode is alternately open circuit and short circuit.

When at a particular point in space, i.e. where a vehicle receiver may be, the signal level oscillates (because of the changing cable terminating impedance) between a high level and a lower level, then the effective signal level will be some 0—3 dB down on the higher level. The precise reduction in signal level will depend on the difference between the high and low levels at that point and also on the AGC mechanism in the receiver.

The alternative arrangement shown in Fig. 3 utilises varactor diodes 21, 22 and inductances 23, 24 to simulate an additional length of cable. The applied modulating bias causes the additional length to act as a phase modulator of the reflected r.f. signals. The standing wave pattern resulting from the sum of the transmitted and reflected signals will thus vary in accordance with this phase modulation.

In one embodiment of the invention the cable can be used for directivity control. As shown in Fig. 1, the message transmitter 4 is connected to the two cables 5 and 6. However, each cable has a separate audio frequency oscillator controlling the bias applied to the far end termination, as shown in Fig. 4. Each of the audio oscillators 30, 31 can operate at either one of two distinct frequencies f_1 and f_2. The arrangement also includes a switch 32 which determines at which of the two frequencies each oscillator operates. For example when oscillator 30 operates at f_1 then oscillator 31 operates at f_2 and vice versa. Both lengths of cable are terminated in the manner previously described. Thus, on cable 5 there will be a standing wave pattern varying at f_1 and on cable 6 a pattern varying at f_2.

In the mobile receiver there are two frequency sensitive switches and control logic. The receiver can be set to one of three states depending on signal received.

1. Overall field strength below a pre-set level — no message will be received.

2. Overall field strength above a pre-set level and f_1 sronger than f_2.

3. Overall field strength above a pre-set level and f_2 stronger than f_1.

The control logic in the receiver is arranged to switch the receiver on when state (1) changes to state (2) and off when state (3) changes to state (1). Thus these 2 cable halves may be used to send a message either to vehicles travelling west to east or only to vehicles travelling in the opposite direction, depending on which half is modulated at f_1 — that is the setting of switch 32.

Alternatively both cables may be modulated by both messages in a time multiplexed form and the receiver so organised that the message time slot chosen depends on whether f_1 came on before f_2 or vice versa.

The length of each cable and the message transmission cycle duration are such that every vehicle travelling at normal speeds will remain in the effective field of each cable long enough to be able to receive at least one complete and uninterrupted message transmission from each cable.

WHAT WE CLAIM IS:—

1. A radiating cable arrangement comprising a length of coaxial cable provided with longitudinally extending radiating means, means for feeding the cable at one end with modulated radio frequency signal, means for applying to the same end of the cable an audio frequency modulated bias

signal, and at the other end of the cable means for terminating the cable and means responsive to the bias signal for modulating the standing wave pattern of the radiated signal at the frequency of the bias modulation.

2. An arrangement according to claim 1 wherein the means for terminating the cable comprises a resistor connected between the inner and outer conductors of the cable.

3. An arrangement according to claim 2 wherein the means for modulating the standing wave pattern comprises a pin diode connected between the inner and outer conductors of the cable and a capacitor connected in series with the resistor.

4. An arrangement according to claim 1 wherein the means for modulating the standing wave pattern comprises a plurality of inductance and varactor diode networks, which together simulate a length of coaxial cable, connected between the cable end and the terminating means which is comprised by a resistor shunting the inner and outer conductors of the cable.

5. An arrangement according to any preceding claim wherein the means for feeding the cable with modulated radio frequency signal is connected to the cable by an isolating capacitor to isolate the feeding means from the audio frequency modulated bias signal and the means for applying the bias signal is connected to the cable by an isolating inductance to isolate the applying means from the r.f. signal.

6. An arrangement according to any preceding claim including a second length of cable similar to the first and having a similar terminating means and standing wave modulating means, the radio frequency means being adopted to feed both lengths of cable with two modulated radio frequency signals, each length of cable having a separate means for applying an audio frequency modulated bias signal, each such bias applying means being capable of applying a bias signal modulated at either of two different audio frequencies, and a switching control means arranged to set each of the bias applying means to one of the audio frequencies.

7. A radiating cable arrangement substantially as described with reference to the accompanying drawings.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1976.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

1431243 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

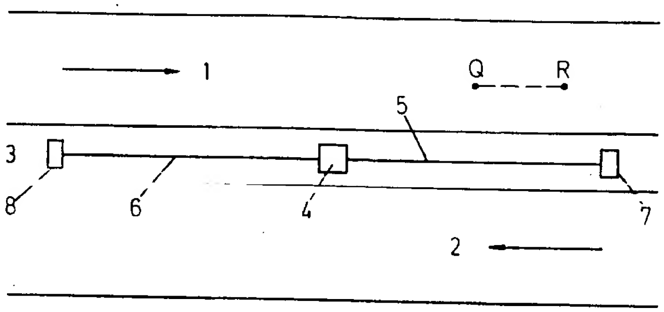

Fig. 1.

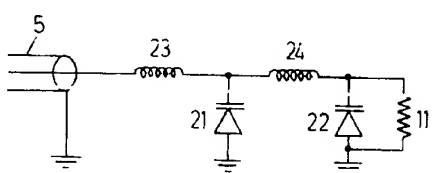

Fig. 3

1431243 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

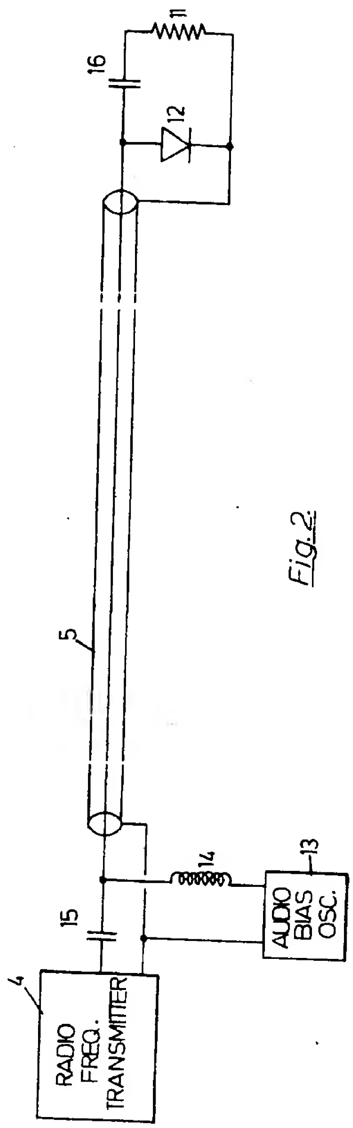

Fig.2

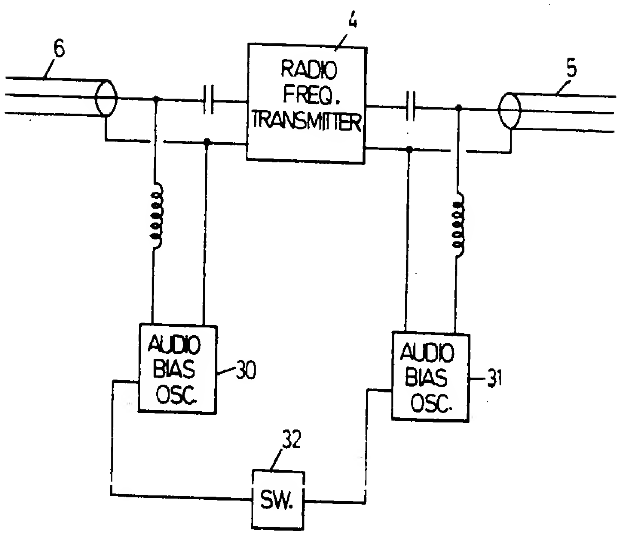
4
6
RADIO
FREQ.
TRANSMITTER
5
AUDIO
BIAS
OSC.
30
AUDIO
BIAS
OSC.
31
32
SW.

Fig.4.